REMARKS/ARGUMENTS

The present Amendment is responsive to the non-final Office Action mailed September 29, 2008 in the above-identified application.

Claims 25, 33 and 35 are canceled without prejudice or disclaimer. Further, new claim 45 is added so as more fully to claim patentable aspects of applicant's invention. New claim 45 is fully supported by applicant's disclosure. Therefore, claims 1-24, 26-32, 34 and 36-45 are the claims currently pending in the present application.

Claims 1-24, 26-32, 34 and 36-44 are amended to clarify features recited thereby. These amendments are fully supported by Applicant's disclosure. See, for example with reference to the automatic establishing of a target action for each interdependent unit independently and without reference to the automatic establishing of a target action for any other interdependent unit, Specification, page 8, lines 8-13, page 11, lines 23-31, page 15, lines 9-17 and page 17, lines 9-23.

Applicant thanks the Examiner for acknowledging the claim for foreign priority and the receipt of the priority document.

Rejection of Claims 1, 18-23, 26, 32, 33 and 36-43 under 35 U.S.C. § 102

Claims 1, 18-23, 26, 32, 33 and 36-43 are rejected under 35 U.S.C. § 102 as being anticipated by Ozawa et al., U.S. Patent No. 5,055,755. Reconsideration of this rejection is respectfully requested.

According to a dominant view in the field of robotics, allowing a number of units of a robotic system to control themselves independently of the target actions of other units of the system will result in an unstable and unproductive set of actions for the system. For example, the Root Locus Technique is a technique to assess the control stability of a robotic system. The Root Locus Technique predicts instabilities that will be introduced or be present in a robotic system in which each unit in an interdependent robotic system is allowed to have independent control of itself.

Without intending to limit the scope of the claims, according to an aspect of applicant's invention as claimed in claim 1, local independent control of each unit of a robotic system is provided in accordance with the surprising insight that, in allowing each unit automatically to set

a target action independently and without reference to the target actions of other units of the system, a common goal for the system can be achieved in an efficient manner, as described, for example at Specification, page 15, lines 9-17 and in the example provided thereafter with respect to overcoming a physical obstacle and as described in Figures 3 and 4 with respect with MATLAB simulink simulation software, Specification, page 17, lines 9-23 *et. seq.* One effect or advantage that may arise from the method according to claim 1 is the ability to control redundant degree of freedom (DOF) manipulators as a natural outcome of a truly distributed control of the system. In this way, without a theoretical limit on how many degrees of freedom are redundant, the system can effectively accomplish its target outcome. By way of contrast, centralized control systems can only provide non-redundant solutions by substituting heuristic conditions to deal with redundancy.

Thus, according to the method recited in claim 1, cooperation between multiple arms may automatically be provided, if desired, by local sensing and incorporation of obstacle information in the incorporation of extra constraints such as orienting the last link to mean a constant attitude, (for example, for paint spraying a part) by judicious choice of roles for various parts of a system and thus achieve decentralized control of the robotic system.

This is in stark contrast to prior art methodologies, which are all based on the idea that the achievement of a complex goal, such as performing by an interdependent system a series of movements that involve the manipulation of a number of interdependent units, requires some form of <u>central coordination</u> if the goal is to be productively and efficiently achieved. In fact, when an embodiment of a claimed invention was modeled utilizing the Root Locus Technique the presence of instabilities was predicted.

Claim 1 requires a method for controlling a system comprising automatically establishing a target action for each interdependent unit of the plurality of interdependent units, wherein in the automatically establishing of the target action for each interdependent unit, the target action is established independently of, and without reference to, the target action for any other interdependent unit of the plurality of interdependent units.

Ozawa discloses a control system entailing a central control-oriented technique, in which calculation of a locus for the end-effector (such as a hand of the robot) is not given to the same dedicated control center. Ozawa discloses that any one of the centers that are locally controlling

their coordinated part of execution of a centrally commanded trajectory, known as the hand locus, may effect control. In particular, Ozawa discloses that, in order to optimize the speed of operation, central control is passed to the processing center that is least computationally loaded. Accordingly, the center that performed calculating the hand locus iteration k of control chooses the controller for the next succeeding iteration, iteration k+1, as the controller to succeed it. Thus, a single central command center at any given time controls operations, and each of the centers is capable of central control but performs central control only if chosen in the previous iteration of control. If a fault occurs in any of the centers in associated communication links, then Ozawa discloses that a new, real-time hand locus, recalculated in every iteration, is provided for, and that the fault is taken into account by rerouting data to the new center (Ozawa, column 9, lines 43-56).

Ozawa discloses that a locus is calculated for the desired motion of the end-effector (Ozawa, Figure 17) utilizing a main control center to achieve motion control (Ozawa, column 1, line 20). Thus, Ozawa discloses the conventional technique of determining an end-effector path trajectory using "one of said distributions controllers" to serve "as a main controller" (Ozawa, column 10, line 10). Ozawa thus relies on information from the environment transmitted to a control center that provides a centralized control, which blends the information about the position of units of the system and calculates goals for all of the units.

Ozawa does not disclose or suggest requiring a method for controlling a system comprising automatically establishing a target action for each interdependent unit of the plurality of interdependent units, wherein in the automatically establishing of the target action for each interdependent unit, the target action is established independently of, and without reference to, the target action for any other interdependent unit of the plurality of interdependent units. That is, while Ozawa discloses a method for controlling a system that includes interdependent units that achieve a common outcome, Ozawa does not disclose or suggest that the units act independently of and without reference to the target action of other units, as required by claim 1. As discussed, Ozawa discloses that the units do not act independently of the target actions of other units but that, instead, central control of the system is passed to successive processing centers. Thus, Ozawa discloses a centralized control system, not a decentralized method. Accordingly, Ozawa does not disclose or suggest recitations of claim 1.

Claims 18-23, 26, 32 and 36-43 depend from claim 1 and are therefore patentably distinguishable over the cited art for at least the same reasons. Claim 33 is canceled without prejudice or disclaimer and the rejection is therefore moot with regard to this claim.

Rejection of Claims 2-13, 24, 25, 27-31, 34, 35 and 44 under 35 U.S.C. § 103

Claims 2-13, 24, 25, 27-31, 34, 35 and 44 are rejected under 35 U.S.C. § 103 as being obvious from Ozawa in view of Seraji, U.S. Patent No. 5,414,799. Reconsideration of this rejection is respectfully requested.

Claims 1, 3 and 24 require a method for controlling a system comprising automatically establishing a target action (or automatically deriving an operation action, per claim 24) for each interdependent unit of the plurality of interdependent units, wherein in the automatically establishing of the target action (or in the automatically deriving of the operation action) for each interdependent unit, the target action (or operation action) is established independently of, and without reference to, the target action (or operation action) for any other interdependent unit of the plurality of interdependent units.

Seraji does not cure the above-discussed deficiencies of Ozawa as they relate to the above noted features of claims 1, 3 and 24. Seraji discloses a technique for adaptive control for a single robot arm or manipulator modified and applied to multiple robot arms by utilizing system coordinated manipulators (Seraji, column 1, lines 23-28). Seraji discloses that an arm is the basic unit of control that has three degrees of freedom or more. As would be well known by a person of ordinary skill in the art, when a system has three or more degrees of freedom, combined movement complexity and the successful operation of the system become major control issues, both in terms of mathematical complexity and computational achievability. This is because a solution depends upon choosing an end-effector trajectory using some method that must master coordinating the operation of each link of the system.

Seraji extends the single arm control technique to allow for three scenarios (position-position, position-hybrid, and hybrid-hybrid) but also uses a central control system. In particular, Seraji discloses the masterminding of sets of degrees of freedom of three or more in a single arm, even for a system in which there exist dependents or interdependents between the cooperating arms. Seraji acknowledges that in a multiple-arm system, the cross-coupling of control effects taken by one arm result in what are seen as disturbances (Seraji, column 4, line 7) by the control

center of the other arm. However, Serjai does not disclose or suggest any kind of unit independence down to one degree of freedom.

Seraji discloses three control scenarios. In each of these control scenarios, the multiple-arm (multiple-object) configuration is an extension of previous technology. There is global information detected from the part (a work piece) being manipulated, which is shared to all arms in the form of position and/or force. Seraji than calculates the positions of all the links in one arm to satisfy a position/force equation (algorithm) and adjusts, <u>via a central controller</u>, all the links accordingly. This algorithm then executes in parallel for each arm in the multiple-arm configuration in an interdependent manner through both arms working on the same work piece.

Like Ozawa, Seraji requires a predefined end-effector trajectory calculated for its application, and states that "end-effectors track reference position trajectories" (Seraji, column 4, lines 3-6). Seraji uses a single central control algorithm, the trajectory of the work piece affected by multiple-arm coordination (Seraji, Figure 5), to cope with unknown parameter values using both force and position sensing. Accordingly, even taken together in combination, Ozawa and Seraji do not disclose or suggest the recitations of claims 1, 3 and 24.

Claims 2, 4-13, 27, 28 and 30 depend from claim 1, claims 34 and 44 depend from claim 3, and claims 29 and 31 depend from claim 24, and they are therefore patentably distinguishable over the cited art for at least the same reasons as their respective base claims. Claims 25 and 35 are canceled without prejudice or disclaimer and the rejection is therefore moot with regard to these claims.

In view of the foregoing, withdrawal of the rejections and allowance of the claims of the application are respectfully requested.

Respectfully submitted,

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